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APPLICATOR FOR PRECISION PLACEMENT OF CHEMICALS IN SOIL

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ABSTRACT

A machine for precise placement of chemicals was designed and constructed for use in research studies. Placement, both lateral and vertical, may be easily and conveniently changed in a few seconds. Different materials may be used with a minimum amount of cleaning and lost time. Uniformity of distribution of the material in the row depends upon the skill of the operator in loading the belt uniformly. With a little practice, most operators can become proficient in a short time. The rate of application may be altered easily and quickly. The machine may be easily detached from the tractor, and transportation of the equipment with and without the tractor can be accomplished by a trailer and pickup truck.

This machine has proved to be very satisfactory for use in plots where rate of application, formulation of insecticide, and placement of the material are subject to frequent change.

APPLICATOR FOR PRECISION REPLACEMENT OF CHEMICALS IN SOIL [1]

By Richard F. Dudley and R. L. Ridgway [2]

INTRODUCTION

Recent studies have indicated that placement of systemic insecticides in the soil can greatly affect plant uptake (4).[3] These studies also pointed out the need for applicators that will apply precisely and place varying amounts of insecticides in the soil at exact lateral and vertical positions in relation to seeds or plants. For many years agricultural engineers have designed and constructed machines that can accurately place fertilizers in plots of almost every crop grown. Many of these machines are described in the "Directory of Special Fertilizer Application Machines and Devices Used in Research."[4]

There was also need for an applicator whose design would allow most operators to learn to handle the machine efficiently in a short time, and for one that could be moved easily from place to place by use of fairly light equipment, such as trailer and pickup truck.

REQUIREMENTS OF APPLICATOR

Previous experience indicates that a machine like the ones designed and constructed by Hudspeth et al. (2) and Dudley et al. (1), but modified to some extent, would have the operating characteristics needed for applying systemic insecticides to soil. Features considered desirable for optimum efficiency of the applicator included the following:

1. Adjustment should be easy, quick, and positive so that insecticides can be placed in nearly any position in relation to the seeds or plants.
2. Application of insecticides should be possible at a constant rate whether large or small amounts of material are being metered.
3. Speed of tractor travel should not affect rate of insecticide application.
4. Design should allow easy and thorough cleaning of the applicator for different lots or types of chemicals.
5. Applicator should be adaptable for use on field-size plots and on smaller experimental plots.
6. Clearance should allow applicator to be operated in established crops without damage to plants.
7. Applicator should be tractor mounted, power operated, and easily transported from one location to another.
8. Applicator should be easily detachable (preferably equipped with a three-point hitch) so that the tractor can be used for other purposes.

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[2] Research agricultural engineer, Agricultural Engineering Research Division, Bushland, Tex., and entomologist, Entomology Research Division, College Station, Tex., respectively, U.S. Department of Agriculture.

[3] Underlined figures in parentheses refer to Literature Cited at end of publication.

[4] Directory is prepared by The Council on Fertilizer Application and is published by National Plant Food Institute, 1700 K Street, NW., Washington, D.C. 20006. Copies of the directory may be obtained free of charge from this organization.

DESCRIPTION OF APPLICATOR

The basic parts of the applicator are available from commercial sources and consist of a conventional three-point hitch, double toolbar, and two adjustable depth-gage wheels. The three-point hitch is bolted directly to the front toolbar. The double toolbars are each 2 1/4 inches square and 8 feet long and are spaced 20 inches apart by use of five toolbar spacers. The two depth-gage wheels have 15-inch tires and are attached to the rear toolbar (fig. 1).

Two smaller toolbars (fig. 1, A), mounted 8 inches below the heavy double toolbars, are 1 1/2-inch cold-rolled square shafting 8 feet long. These toolbars are positioned by flat, mild steel straps measuring 3/8 of an inch thick and 2 1/2 inches wide (fig. 1, B) that are bolted to each of the five toolbar spacers. Lengths of 3/8-inch by 3 inches of flat mild steel strap (fig. 1, C) are welded between the front and rear toolbars. Square structural tubing in sections 1 inch long and slightly more than 1 1/2 inch square on the inside (fig. 1, D) are welded to the ends of the lower toolbar supports. These supports allow the two lower toolbars to be moved sideways. Side movement of these toolbars is controlled through the rack and pinion, which the operator adjusts to precisely regulate the distance chemicals are placed from the plant rows. Racks are mounted on the lower toolbars; pinions with handles are mounted on the support of the lower toolbar (fig. 2, E). These devices can be seen also in figures 1 and 3.

Soil openers, through which the chemical is applied, are mounted on a stub toolbar at the rear of a parallelogram linkage mechanism (fig. 3, F). This mounting holds the opener at the same suction angle regardless of the opener's depth in the soil. The side members of the parallelogram linkage are made of bar steel measuring 3/8 inch thick by 1 1/2 inches wide by 10 inches long (fig. 1, G). The front crossbars of the linkage (fig. 1, H) are rigidly bolted to one of the sliding cold-rolled square toolbars.

Two rockshafts are made of two lengths of square cold-rolled shafting measuring 1 1/4 inches by 80 inches long (fig. 1, I), and are mounted above the two large toolbars to carry the lift arms for the applicators. The 12-inch lift arms are mounted on the rockshafts by clamps and oversize square channels so that the lift arms will slide laterally on the rockshaft to align above the soil openers. The lever quadrants (fig. 2, J) are mounted over the rockshafts, and the hand levers are connected directly on the rockshafts. The quadrants are designed so that an adjustment change of one notch lifts or lowers the soil openers 1 inch. Soil openers can be adjusted for a depth of 0 to 6 inches.

A 6-compartment belt tray (3) is mounted above the toolbar to meter the experimental materials (fig. 4).

In this illustration, the two center compartments are empty; the remaining compartments contain fillers inserted in the trays when small amounts of material (5 to 50 lb. per acre) are metered. These fillers can be removed when larger amounts of material (50 to 2,000 lb. per acre) are metered.

The belt tray is driven by a power takeoff from the tractor through a five-to-one speed reducer and a countershaft that provides four sprocket changes to obtain the desired belt movement per plot length. If desired the belt tray can also be ground driven from the machine's depth-gage wheels. Chain-driven commercial applicator boxes, designed to disperse granules, are mounted on each side of the machine for use on a large acreage where the rate of application is constant (figs. 1 and 4). If a direct ground drive is desired, the commercial applicator boxes may be driven from the gage wheels by adding sprockets and drive chains.

A seat for the operator is located above the three-point hitch. The supply of insecticide is carried in the rectangular tray mounted to the left of the seat (fig. 1).

CALIBRATION OF APPLICATOR

The belt tray is calibrated by using sprocket combinations that will move the belt far enough while the applicator is being driven over a plot of specified length. A supply of 6- to 24-tooth sprockets allows the machine to be used on plots ranging from 20 to 200 feet in length. Sprockets

Figure 1.--Front view of applicator showing heavy front and rear toolbars, toolbar spacers, and attachment of depth-gage wheels to rear toolbar. Numerous other structural features, identified by letters, and the chain-driven belt tray and commercial applicator box are described in the text.

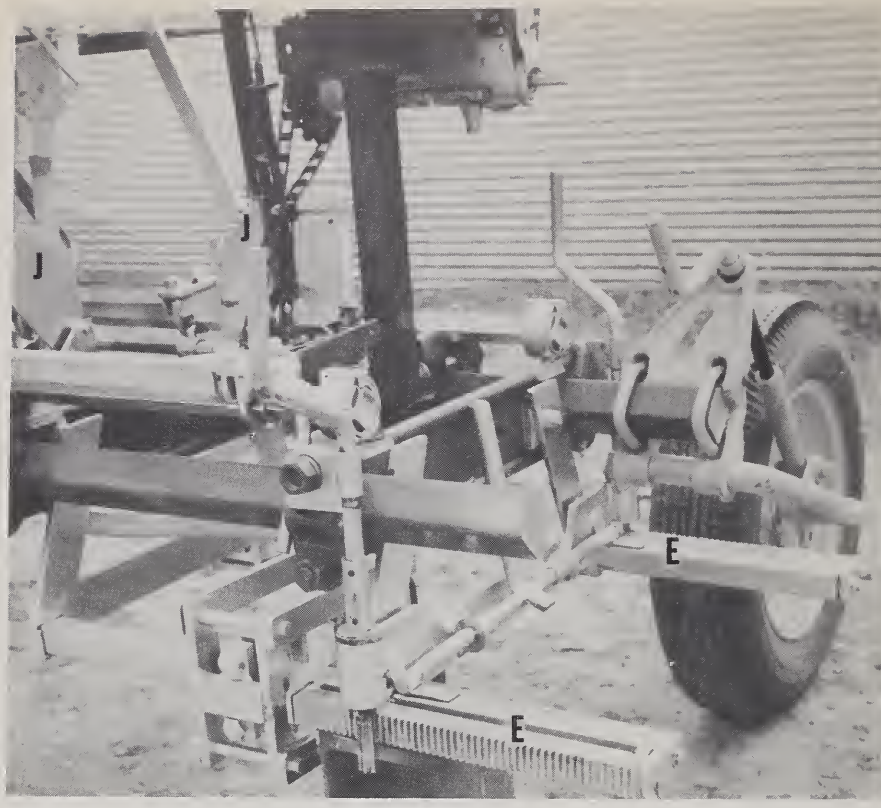

Figure 2.--Rack and pinion hookup on applicator. This mechanical feature enables the operator to vary precisely the placement of chemical in the soil at distances ranging from 2 to 18 inches from plant rows.

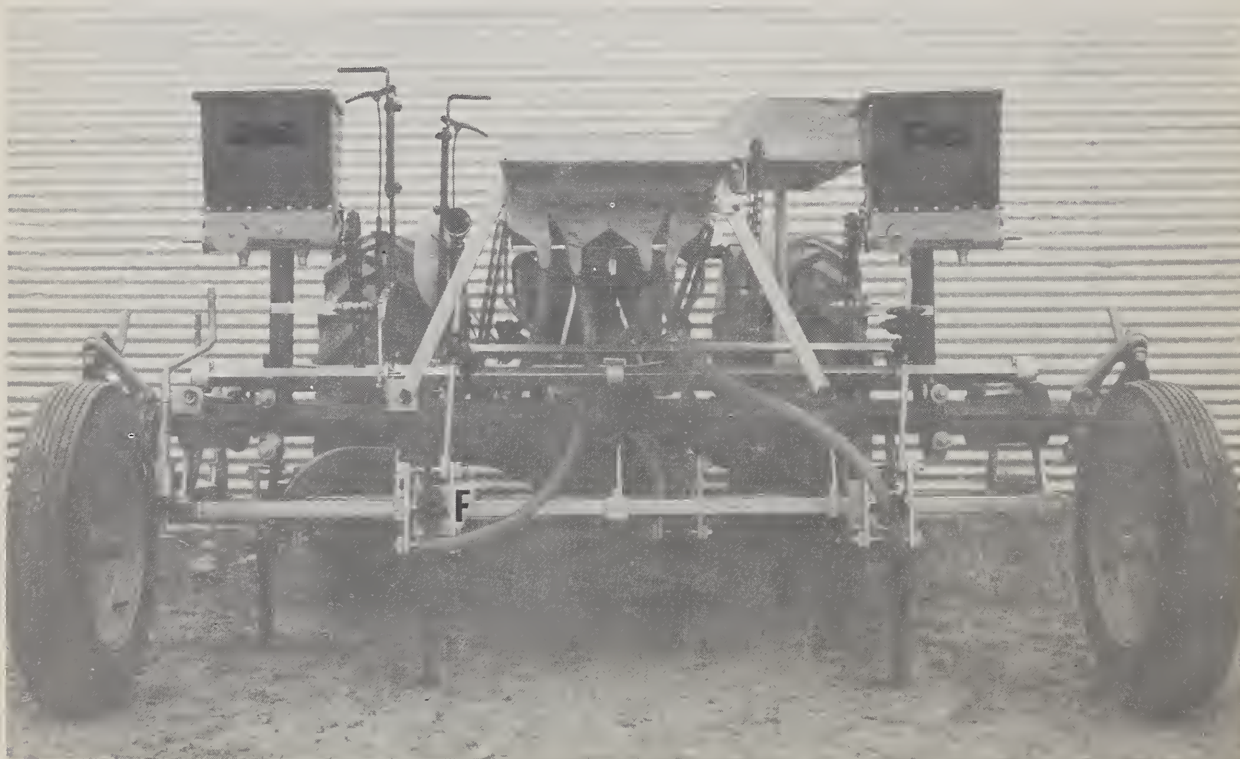

Figure 3.--Rear view of applicator.

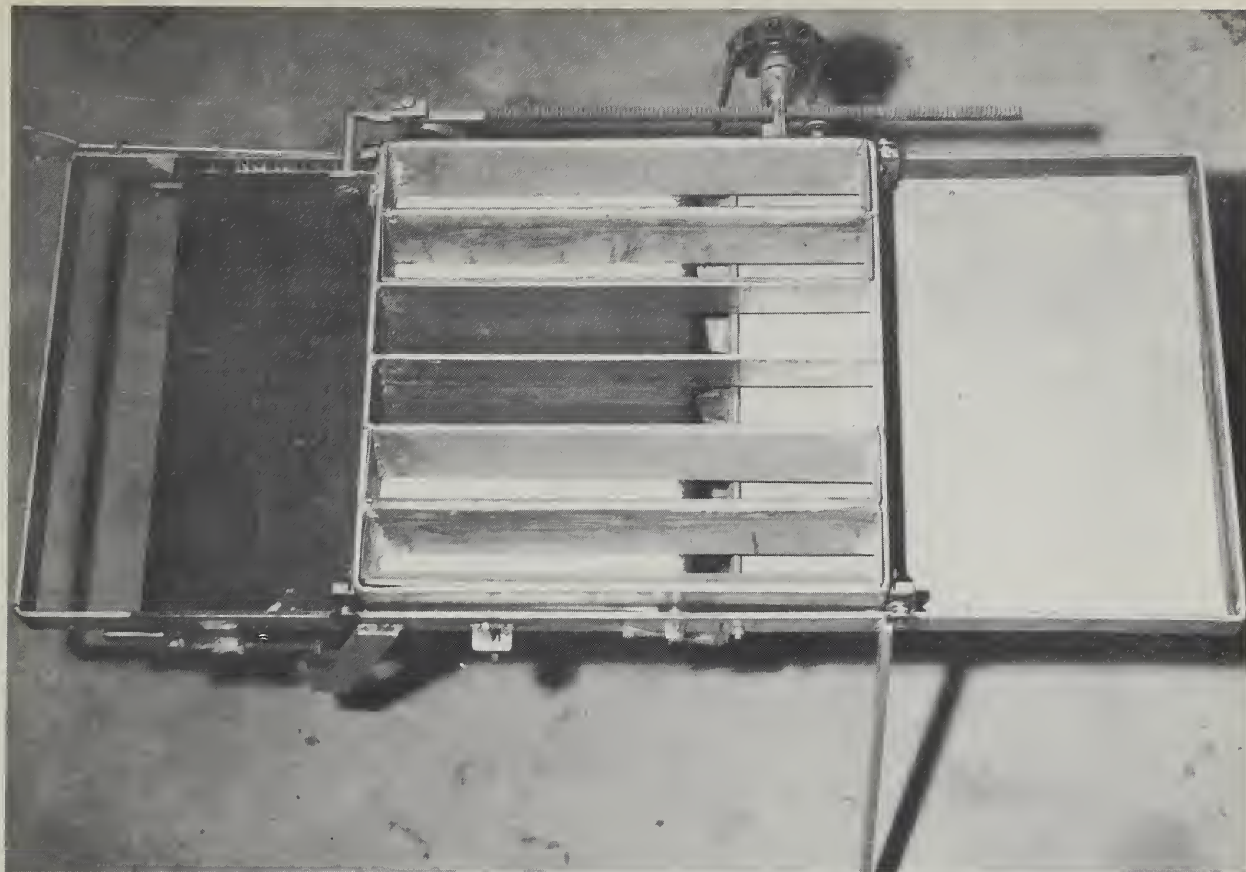

Figure 4.--Top view of 6-compartment belt tray, removed from machine, for metering experimental material.

are constructed so that they may be changed easily. Cast iron chain is used so that the operator can change the length of it by hand.

The volumetric method of measuring the amount of material to be applied is usually satisfactory. In this method the amount of material per plot and per opener is first calculated. This amount of material is then placed in a can, and the height to which it fills the can is marked on the outside of the can. The can is cut off on this line. The amount of material applied per plot is measured out with this can. In this method of calibration, the size of the measuring can should be less in diameter than it is in height to reduce the error when measured-out material is not level in the can. A calibration can is needed for each material and for each rate of application. When greater accuracy of dosage is desired, the material can be weighed out and placed in a separate container for each plot and each opener. Then, the operator evenly distributes the preweighed material on the belt tray for each application.

If the commercial applicator boxes for granules are used, calibration is accomplished by following the manufacturer's directions or by computing the desired amount of output per row-foot of travel and measuring or weighing the material.

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